THE BRUSH ELECTRIC LIGHT

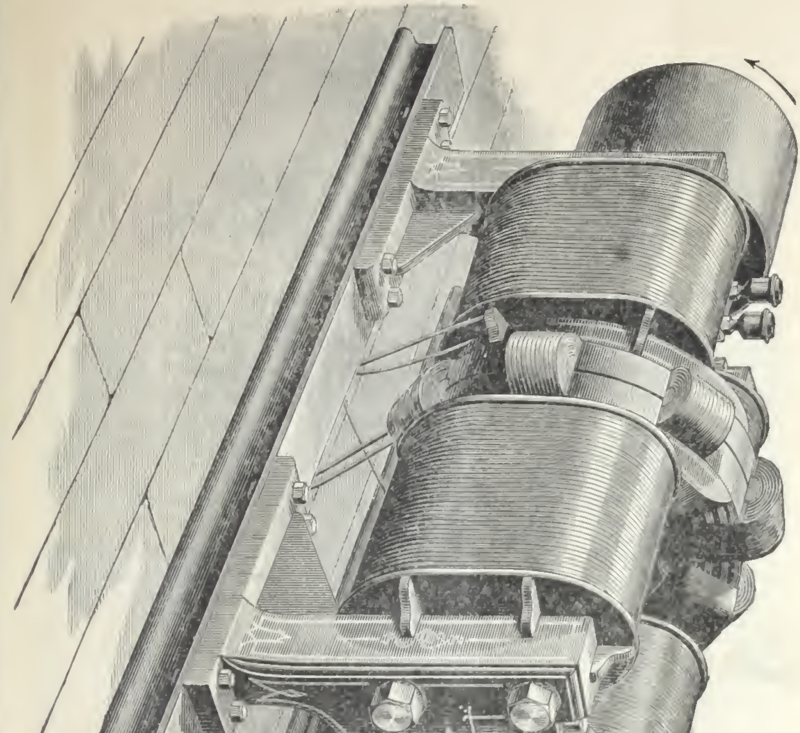
AND

ELECTRO-PLATING APPARATUS.

MANUFACTURED ONLY BY

THE BRUSH ELECTRIC COMPANY,

CLEVELAND, OHIO, U. S. A.



THE BRUSH DYNAMO-ELECTRIC MACHINE.

SIZE NO. 8.

DIMENSIONS, 89 inches long, 28 inches wide, 36 inches high.—WEIGHT, 4,800 pounds.
PULLEY, 20 inches diameter, 12 inches face.—BELT, 12 inches.
SPEED, 675 to 700 revolutions per minute.
This Machine gives 40 lights of 2,000 C. P. each in one circuit and requires 36 H. P.

INTRODUCTION.

The Brush System of Electric Lighting is the only one, of all the proposed systems of Electric Lighting, which has passed the experimental stage and clearly demonstrated its rights to a secure place among the practical lights of the day. An immense field is opening before electric light, in which no other known illuminator is so "well fitted to shine." It is not, however, a *boundless* field. It is no more to be expected that it will ever entirely displace gas or oil, than that locomotives will displace horses. Gas will probably continue to hold its own as the light for domestic and small uses in cities and towns, and oil will keep the field in similar situations in villages and hamlets.

There are, however, an immense number of situations in which Electric Light is the only artificial illuminant that can be economically and profitably used, not only because it costs less, but because it furnishes a *volume of light* obtainable in no other way. Such situations are ***Rolling Mills, Iron Foundries, Moulding Shops and all Factories, Mines, etc., where*** THERE ARE LARGE ROOMS; AS WELL AS DOCKS, WAREHOUSES, DEPOTS, OPEN SPACES, ETC. In such places Electric Light is being very largely used. There are other Factories, Mills, Shops, Large Stores, Hotel Offices, Theatres, Public Halls, etc., in which gas or oil has been used and they have furnished a sufficient amount of light, but, when the cost is counted up and the result compared, not only with the cost but with the other great advantages of Electric Light, it is found that the latter has the decided advantage. There are still other places in which when the cost of the necessary power to drive the machine, taken in connection with the fact that a comparatively small amount of light is needed, in a number of rooms, or for a very short time each day, are considered, it will be found that Electric Light possesses no advantage in point of *cost* over the other lights, yet still retains its great value as a pure white light, giving no heat and free from danger of explosion.

VARIOUS USES OF OUR LIGHT.

It has been used to great advantage, as will be observed by testimonials, in MANUFACTORIES OF TEXTILE FABRICS, COTTON, WOOL, LINEN AND SILK OF EVERY DESCRIPTION; IN IRON MILLS; MACHINE SHOPS; ROLLING MILLS; PETROLEUM REFINERIES; PAPER MILLS; DRY GOODS AND CLOTHING STORES; PARKS; DOCKS; OPEN SPACES; DEPOTS; PRINTING ESTABLISHMENTS; COLLEGES; HOTEL OFFICES AND DINING ROOMS, CIRCUS TENTS; SMELTING WORKS; OCEAN AND RIVER STEAMERS, MINES; MATCH FACTORIES, ETC., ETC.

Progress of Electric Light.

In the year 1832, Faraday, the illustrious English philosopher and scientist, announced that he had discovered what has since been called magnetic induction, or the induction of a current of electricity in a coil of wire brought near a permanent magnet and the phenomena attendant thereupon. The announcement created great interest in the scientific world, and almost immediately instruments and machines were made by electricians and others to test and utilize the newly discovered facts and laws. Among these early and very crude machines may be named those of Clarke, Nollet, Holmes, Wilde, Ladd, and others. These were all imperfect machines, and it was not until quite recently that very material progress was made in perfecting apparatus that should fairly represent the value of Faraday's discovery.

The Gramme (French) and Siemens (Anglo-German) are types of machines much more successful than any of their predecessors; but when Mr. Brush entered the field with his machine in 1876—after forty-four years of experience and research by others—there was no machine known either here or abroad, that was in any respect a practical or commercial success. No machine was then known that would furnish a current for a number of lamps and permit of their being burned in one circuit, with steadiness and uniformity. Very soon after Mr. Brush entered the field, he presented to the public an apparatus which was entirely clear from the defects of all other systems, and, as the public were waiting for just such an apparatus, they welcomed the new comer, and the result is that to-day

THE BRUSH ELECTRIC LIGHT

is practically the sole occupant of the field; for at least forty-nine out of every fifty lights that have been *sold* in this country are BRUSH LIGHTS. At this date, February, 1881, 5,000 Brush lights have been sold for regular industrial use, and the business has only just opened. An idea of the great superiority of the Brush system of lighting may be obtained from the fact that with the largest sized Brush machine *forty powerful electric lights are burned* IN ONE CIRCUIT, *with an absorption in the machine of thirty-six horse power.* No other system of lighting can offer even *one-fifth* of this number of lights on one circuit; and most are confined to a *single light to one machine.*

This vast advantage of the Brush system is due wholly to the valuable new features in Mr. Brush's apparatus; in which it differs from all

other systems. The reader is referred for all these details, and for a full and complete description of the apparatus, to the monograph from the pen of Mr. Brush, which is published in the closing pages.

The Most Convincing Evidence of the value and practical character of the Brush system may, however, be gained from a perusal of the numerous letters from prominent users of the light that are published herewith. In very few of the cases of the first large users of the light were all the lights purchased in the outset, but by degrees, as the value and practical character of the light were developed by actual demonstration.

The Riverside Mills, of Providence, for instance, bought first one, and then a second, and then a third, of our largest sized machines; and, upon the completion of an addition to their already very large establishment, *two more*, so that now they have five machines and ninety-six lamps in all in use. They say that it is the safest, pleasantest, most available and *by far* the cheapest light they can obtain from *any known source.*

The successful use of our light, as indicated by these letters and by the experience of all who are using it, proves that it possesses the following very great advantages over any other known method of illumination:

1st. ***It is a Safe Light;*** there being no dangers in its use at all corresponding to those incurred by the use of oil or gas—such as explosions, leakages, risk from lighted matches, flaring burners, etc. The letter from Hon. Edward Atkinson, of Boston, the first authority in New England on fire insurance, is final and most convincing evidence on this point.

2nd. ***It is a Pleasant Light;*** being pure in color, steady and clear. No other artificial light of any power is as steady as the Brush light. Flickering is practically obviated in the present apparatus.

3rd. ***It is a Healthy Light;*** for it does not vitiate the atmosphere and give off such quantities of heat and noxious gases as do other illuminators, notably gas. Upon this point several of the letters are specific. The air in a room where electric light is exclusively used remains pure, cool and healthful; and in all our experience NO EYES have been injured by it, much as has been said about its brilliancy and power.

4th. ***It is a White Light;*** and therefore the only light available for use at night, where colors are to be observed or matched, a point of importance in many cases. Colors observed by our light are just the same as by daylight. In factories where colored goods are made, and in stores where they are sold, it is the only light that is effective.

5th. ***It is the Cheapest Light*** in ALL places where considerable light is needed, and where power to drive the machines can be obtained or furnished. The evidence in the testimonials we publish is unmistakably clear and convincing on this point, and we do not therefore need to discuss it.

A Point of very great advantage, which will be appreciated by *superintendents and foremen of large manufacturing establishments*, is, that electric light, when properly used, illuminates *all parts* of a shop or factory. In entering a room lighted in the old way, with gas or oil, it will be at once noticed that in order to get any satisfaction at all from the use of such a light, it must be located very near the workmen, leaving the spaces between the workmen and the open spaces in the room, in comparative gloom. If a workman in a shop lighted in this way desires to find a tool, or implement, or a portion of his work, which does not happen to be located near a light, or in its accustomed place, he must go poking about in comparative darkness to hunt for it, and is thus materially delayed in his work. He can also, if so inclined, waste time, unobserved by the superintendent, in portions of the shop not well lighted. Every foreman of a shop will recall numerous instances in which he has, by his unexpected appearance in such parts of the premises, discovered this neglect of duty, or "soldiering" as it is so often called. Displace the old light by the new, and note the result. All is now changed. Every part of the shop is now *light.* The foreman can stand at any point which commands a view of the men and can instantly see what they are doing, and he has them as fully under his observation as by day. Now a hunt for tools, or implements, or parts of work, is a short one, for there is *light everywhere.* In all factories where our light is used this is one of the first points of improvement noticed, and the result is that night work in such shops and factories, instead of falling behind day work, both in quality and quantity, is kept up to the standard.

The Whiteness and Purity of Electric Light constitute great points in its favor, in all factories where colored goods are made or in large stores where they are sold. It is impossible to match the thousand and one delicate shades, which are now given to colored goods, by a light which is *yellow* in color, as is the fact with gas and oil. With our light the most finely shaded tints and colors are as readily detected as by daylight. In the many ***Dye Houses*** where our light is used it has proved to be absolutely indispensible, where it is desired to carry the work forward into the late afternoon or early evening, or *all night*, as is often the case.

The experience of the Riverside Mills of Providence, the Atlantic Mills of the same place, the Willimantic Linen Co., the Oswego Falls Woolen Mills, Thos. Dolan & Co., and the Messrs Cheney Bro's Silk Factory, not to speak of many others, strongly confirm this statement.

In the large number of factories and mills where our light has been adopted, it is found that all operations which had hitherto been restricted to the daylight hours may now be carried on by means of the Electric Light, with the most complete satisfaction.

The Safe Character of Electric Light is universally admitted. The letter of the Hon. Edward Atkinson upon this point, referred to above, is of the most gratifying character. The accidental fires which so often occur in factories and mills, and which so frequently are traced to the

careless use of matches, to explosions of oil lamps, to leaks from defective gas pipes, to flaring and wind-blown gas flames, and to similar causes, may be expected to disappear at the approach of Electric Light, with its harmless copper wires, conveying currents of electricity to the non-explosive, and almost non combustible carbon points. These are covered in exposed positions by the glass globe, which may, if desired, be air tight, and thus positively prevent explosive gases or combustible materials from without, from coming into contact with the incandescent carbon points, incapable of communicating fire to any thing not absolutely *in contact* with their heated surfaces. The naked hand may be held within an *inch* of the spot from which the immense light, produced by one of our lamps, is emanating, without any danger of burning it. It radiates far less *heat* than an ordinary gas burner, while giving light equal to *an hundred* gas burners. This peculiarity of the light is commented on in the testimonials from the Riverside Mills, Willimantic Linen Co., Oswego Falls Manufacturing Co., and others, and is of very great importance, especially in factories where many employes are engaged.

The Cheapness of Electric Light in all locations adapted to its use is now generally admitted. We will call attention to several cases. The Riverside Worsted Mills, of Providence, R. I., formerly used in their mill-rooms 578 six-foot gas burners. These gas burners did not give the desired amount or kind of light, and yet their cost was *enormous*, for, as is well known, this establishment runs night and day the year round, and consequently they would use artificial light at least 3000 hours per year. The 578 gas burners consumed 3468 cubic feet of gas per hour, or 10,404,000 cubic feet per year, which, at a cost of $2 per thousand cubic feet, amounted to an expenditure of $20,818.00 *per annum.*

Desiring to get more and better light, at a less cost, this mill adopted the Brush Electric Light and have displaced the 578 six-foot gas burners with 71 of our lights. (25 other lamps are located where gas was not used before.) Each of these lights is equal in diffused lighting power to *fifty* gas burners, so that the great increase of light may be inferred. In a letter addressed to us, dated January 1st, 1880, the following items are given as constituting the *total cost* of the 71 Electric Lights:

Carbons consumed per hour..........................	$ 89
Power used for machines, per hour..................	65
Interest on investment in plant, per hour..........	30
Attendance, oil, waste, wear and tear etc., per hour...	36
Total..	$2 20

This amounts in the 3000 hours per year that the lights are used, to the sum of $6,600 showing the ***Enormous Saving of $14,218 per Year Over the Cost of Gas.***

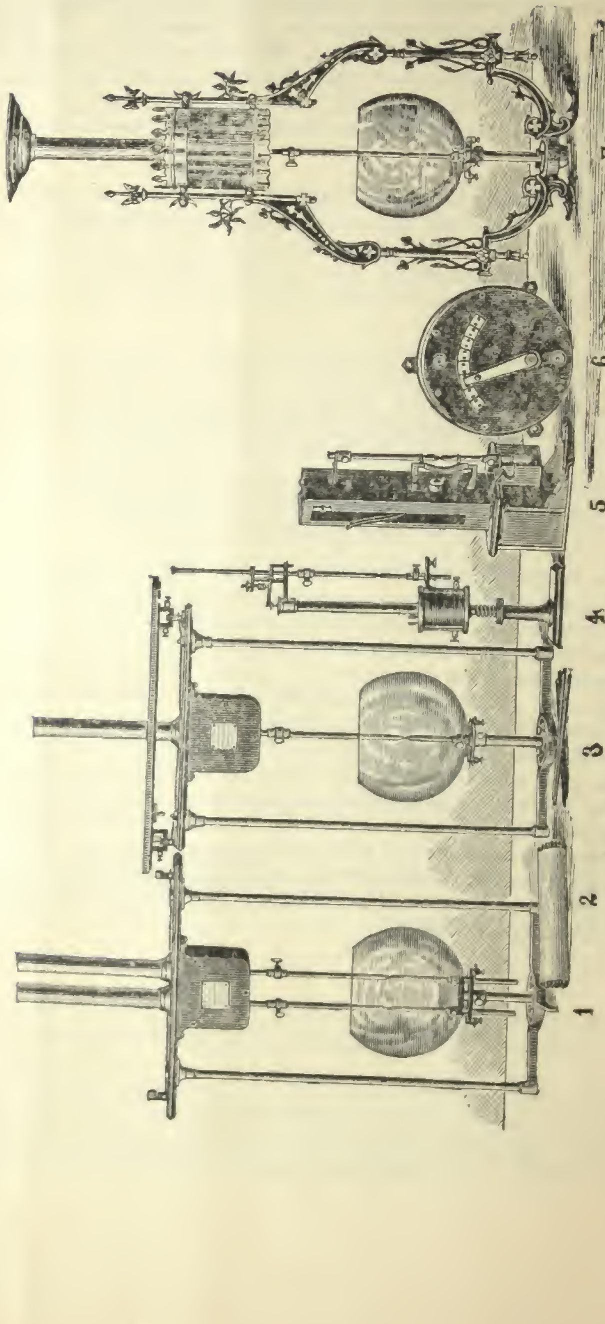
Besides this great economy in first cost, fully five times as much light is obtained from the 71 electric lights as could be given by the 578 gas burners, not to speak of the other great advantages that are mentioned in the testimonials from this establishment. At the Oswego

Falls Manufacturing Company the economy is still greater, for here water power, unlimited in amount, is available, and it costs hardly anything but the investment in the water wheel and its connections. It is safe to state that the 90 Brush lights in use in this mill could not be replaced, so as to produce as satisfactory a light, by 2000 six-foot gas burners of sixteen candle power each, and this amount of gas would cost not less than TEN TIMES as much per hour as the total cost per hour of the 90 Electric Lights.

The Steadiness of the Brush Light is frequently commented upon. A gentleman in New York city recently desired to investigate the subject of electric light, and, without our knowledge, wrote to *all* of the more prominent users of the Brush light to obtain their opinions of it. We afterward heard of his having written, and wrote to him upon the subject. He said in reply:

"I needed information about the practical every-day workings of the light, and have accordingly written to the principal concerns whose names are mentioned in your circular and have the replies of all of them. You would have good reason to be satisfied with the replies in regard to your light. *Every one* of them is favorable and friendly. In no case does flickering seem to give them any trouble, and I should judge from what is said that your light is so steady that no one thinks of the flickering at all. The reports on all other points are favorable."

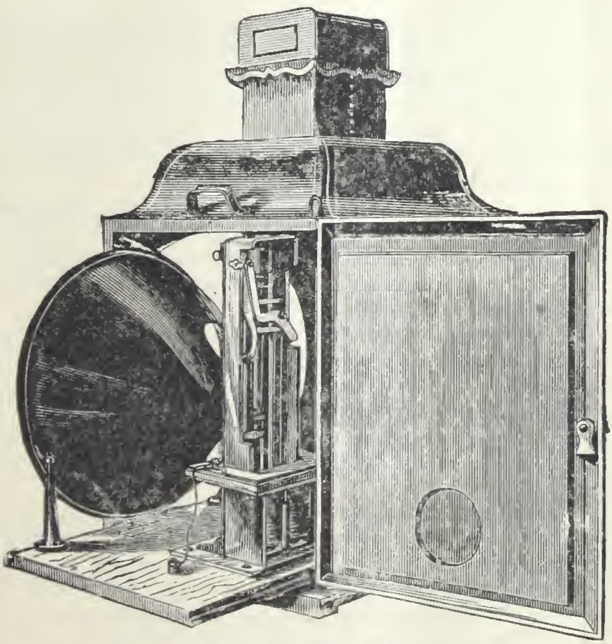
The Simplicity and Durability of the Brush Electric Lighting apparatus are apparent upon inspection and clearly evident from the experience of users. Two per cent. is an ample allowance for wear and tear upon machine and lamps, and with this amount, or even less, annually spent upon them, there is no good reason why they should not last fifty years or more In the machine the only chances for any wear are in the journal bearings and at the commutator. Such great care is exercised in providing the most perfect babbitt-metal bearing surfaces in the journals, and smoothness and accuracy of working, and freedom from sparks at the commutator, that wear is reduced to a minimum. There are numbers of Brush machines that have been in constant use for many months that do not show any perceptible wear and that are in all respects fully as good as new. This is the uniform result, except where carelessness or indifference on the part of attendants permit unnecessary wear by the neglect of oiling or cleaning.



THE DIFFERENT STYLES OF LAMPS USED.—[SEE page 9.]

DESCRIPTION OF LAMPS.

The cut on page 8 shows the various styles of lamps manufactured by us at the present time. In the cut, Fig. 1, shows the form of our No. 3 or double lamps. This lamp is fitted with two carbon rods, so arranged that when one set of carbons is consumed, the second set are automaticall switched into the circuit, and burn until consumed. This is done without any interruption to the light, and these double lamps will burn fourteen hours or more without attention. Fig. 2 shows a package of 25 carbons wrapped up ready for shipment. Fig. 3 shows the No. 2 or single lamp, which burns 7 to 8 hours without attention. Fig. 4 is our focusing lamp, for projections in magic lanterns or similar apparatus. Fig. 5 is our head light lamp for use in reflectors on steamers or on locomotives. Fig. 6 is a dial attachment to be used in connection with our largest machines, and is arranged so that any number of lights from one up to the full number may be burned without varying the speed of the machine. Fig. 7 shows our ornamental lamp, adapted for use in hotels, stores and other places, where a more showy lamp is needed. It can be made either single or double, as desired.



HEADLIGHT LAMP.

With parabolic Reflector and Case complete for use on Steamers and Locomotives.

The Brush Electric Light.

WHAT THOSE WHO ARE USING IT SAY OF IT.

FROM THE RIVERSIDE WORSTED MILLS.

RIVERSIDE WORSTED MILLS, PROVIDENCE, R I., }
December 1, 1879. }

Mr. G. W. Stockly,

Vice President Telegraph Supply Company, Cleveland Ohio

Dear Sir: Your letter asking for a sketch of our experience with the Brush Electric Light is at hand, and we willingly give you such information as you desire.

We had been making some investigations into the electric lighting in use in France, when our attention was called to the American systems on exhibition at the Mechanics' Fair in Boston in the autumn of 1878. After as careful attention to the matter as its then undeveloped state admitted of, we decided that the Brush system, if any, was the light best adapted to our wants, and arranged with your Boston Agent to set up one of your largest machines in our mill on trial.

The machine was set up and started about the 20th of February; its success was instant and complete; so much so that this machine was accepted and another ordered at once. This second machine was started in March, when a third was ordered by telegraph, which was set up and running early in April.

With these three machines we ran through the summer, getting such satisfaction that in September we ordered two more, which are both now running, making in all five of your largest machines running eighty (80) lamps which are now regularly lighting nearly all of our principal rooms. After this experience of nearly a year we have not a word to give you save of praise. Our satisfaction increases as we come to know the machines more thoroughly.

They could not have a severer test than we give them, as our mill runs night and day the year through, and we have not had a moment's delay from, or a dollar's worth of repairs on any of the machines or lamps. The light is all we expected; it is strong and steady, clear and white; it is universally liked by both overseers and help; so much so that we doubt if we could get along now with the help if we were to return to the old gas lighting; certainly we should not get so good work, nor so much of it. We use porcelain globes pretty generally throughout the mill, and we have less complaint of trouble to the eyes than we used to have with gas.

The air of the rooms, too, shows a very marked difference. In our Weave-Room, with its two hundred and fifty (250) gas lights, the air became almost unbearable after midnight in the summer; and the jaded appearance of the men showed how they felt it.

With the electric light there is no such trouble, as the air is as good as in the daytime, and noticeably cooler.

An answer to your question as to how many gas burners would give us as much light as we are getting now, will hardly give a fair test, as we should never think of trying to get so much light with gas.

In our Weave-Room, for instance, we formerly had two burners to each loom close down to the work; now the *whole room* to the peak of the roof and in the furthest corners is almost as light as day; still the figures are interesting.

We had formerly about two hundred and fifty gas burners of seventeen candle power each, a total of 4,250 candle power. We now have twenty electric lamps of two thousand candle power each, a total of forty thousand candle power.

Your other question, "How many gas burners would answer your purpose?" is more satisfactorily answered. Owing to some changes preparatory to setting up new machinery, all our eighty (80) lamps are not at this moment in full service, but by actual count we have seventy-one (71) lamps permanently placed, and these displace five hundred and seventy eight (578) gas burners; that is, there are five hundred and seventy-eight burners already placed that would be lighted were the electric lights stopped.

Estimating these burners at six feet per hour, we should use 3,468 cubic feet of gas per hour, costing, at $2 per thousand cubic feet, $6.93 per hour.

The actual cost of the electric light is as follows:

Consumption of carbons per hour	$ .89
Power used for machines	.65
Interest on cost of machines, say $15,000	.30
Attendance, oil, wear and tear, etc	.36
Total cost per hour	$2.20

Making a saving of four dollars and seventy-three cents ($4.73) per hour, and this saving for the three thousands hours the machines run in the year, is $14,190, and nearly pays for the machines. These figures are *actual*, as we averaged the number of carbons burned for several nights to get the exact consumption of each lamp, and for the consumption of gas we took off a number of the gas burners in use, had them tested on a test meter and averaged them, getting a strong six (6) feet to each burner. Respectfully,

RIVERSIDE WORSTED MILLS.

FROM THE OSWEGO FALLS MANUFACTURING CO.

OSWEGO FALLS, N. Y. Dec 5. 1879

The Brush Electric Light Co., Boston, Mass.:

Gentlemen:—In reply to your inquiry, I have pleasure in saying we are well pleased with the four No. 7 machines which supply 78 globe lights you fitted up for us. The result realizes our sanguine expectations.

The cost of generating the light is *very small*, especially where water power is available. The great merit, however, of the light, is its not vitiating the quality of the atmosphere, which, after a room has been lighted for several hours, remains cool and pure, and therefore is more healthy than any artificial light with which I am acquainted.

Yours respectfully,

D RAMSDEN Supt.

Mr. Ramsden has since ordered other machines, and now has 108 lights in regular use. The gas pipes have been removed from the mill.

FROM CHENEY BRO'S. SOUTH MANCHESTER, CONN.

SOUTH MANCHESTER, Conn., Dec. 3, 1879

The Brush Electric Light Co., Boston, Mass.:

Gentlemen:—In response to your enquiries we would say that the experimental eighteen light machine that you put in at our works promises to be a success. We are experimenting with the machine in different departments of our works in order to fully test its capacity and the cost of lighting our mills as compared with gas. So far the results are favorable, and we think further trials will demonstrate the value and economy of your light. Yours truly,

CHENEY BROTHERS

FROM ATLANTIC MILLS, PROVIDENCE, R. I.

ATLANTIC MILLS, PROVIDENCE, R. I. Nov 11 1879

Brush Electric Light Co., Boston, Mass.:

Gentlemen:—In reply to your enquiry as to the result obtained by us in the use of your Electric Light, we would say that it has given us good satisfaction. For manufacturing purposes we find it *far* superior to any other light, and are confident it is *much* more economical than *any* kind of gas.

The machines and lamps require but very little attention, and need only a man of average intelligence to use them successfully. We expect in the *near* future to light our entire works by the use of your machines.

Very truly yours,

OWENS BROS., Agents.

In July, 1880, 80 more lights were ordered by this establishment, making 116 in all, thus giving the best possible evidence of the success of the light.

FROM THE WILLIMANTIC LINEN CO.

TREASURER'S OFFICE, HARTFORD, Conn., July 5th, 1879.

Brush Electric Light Co., Boston :

Gentlemen :—The six-light electric machine which we put in our Willimantic Mill is running to our entire satisfaction. We have two lights in our winding room, 68 by 80 feet, and four in the mule room, 68 by 200 feet, where we are spinning No. 140 cotton. The entire cost is about equivalent to gas at $1 per thousand feet—the light *far better.* Gas costs us $3.25 per 1,000 feet. I enclose a photograph taken in the winding room after midnight, which gives a very good idea of the power of the light.

In this room the electric light is particularly of value, as colors can be determined as well as by daylight. The light does not raise the temperature. All gas gives out non-respirable gases and consumes oxygen. At the end of the day, when work-people are well tired out, the effect of gas by raising temperature and giving out noxious gases, on the workers, is quite plain (to say nothing of the bad effect on the work). This is particularly noticeable in rooms where there are a good many work people and a large number of gas-burners. The gas raises the temperature in our winding room 13 deg., the electric light *not at all*, as shown by a common thermometer. You will see that this evenness of temperature is very important in the spinning of fine cotton yarns.

Yours truly,

W. E. BARROWS, Treasurer.

TREASURER'S OFFICE WILLIMANTIC LINEN COMPANY,
April 9, 1880.

Mr. Frederick Fosdick, Treasurer Fitchburg Steam Engine Company, Fitchburg, Mass.:

Dear Sir:—Your favor of April 6th to hand. As to our experience with the Electric Light I would say: The first machine, known as the Brush Electric Machine, was purchased February 1st, 1879, and has been used since.

This was a six-light machine. Since that time, January 1st. 1880, we have purchased two machines, one of 18 lights and one of 1 light. The larger of the two is used in our Willimantic Mills, in the twisting room and mule spinning room, where we are spinning No. 120. This machine and its 18 lamps furnish light in place of about 450 five feet gas burners. At lighting up time, with gas, the temperature of the room is raised about 12 degrees Fahrenheit; with the Electric Light there is no change that can be measured. All our work people prefer the Electric Light to gas. In our color room all shades of color can be determined at night as well as in day time. At our spool shop, in the birch woods of Maine, we use one light in the saw mill, 40x60 feet, and run all night. The night gang do as much work as the day gang, and of as good quality. I think it is safe to say with oil lights this would not be done. This light was started January 1st. The man in charge never saw an Electric light or generator till he saw this one. Our man at

Willimantic went up to the works, explained the working of the light, and set it up and returned the next day. It has not been out of order or given the least trouble up to this time, and we do not expect any in the future, a fair illustration of its simplicity. In our new mill, 820x172 feet, we expect to use the Brush Electric Light exclusively. We are now trying the experiment of running one of our mills all night, so far with good results, using the Electric Light.

I should be glad to have you visit our factory, when you can see for yourself just how the thing works.

Certainly it is a very good thing for the health of the work people.

Very truly yours,

W. E. BARROWS, Treasurer.

CHENEY BRO'S SILK WORKS.

SOUTH MANCHESTER, Conn., June 23, 1880.

Brush Electric Light Co., Boston, Mass.:

Gentlemen:—Your favor of the 15th was laid aside for the writer to answer, and in the pressure of other things has been overlooked, which will account for your not receiving a more prompt reply. In regard to your inquiry about our Dye House: length, width, height, etc., and the number of the Brush Lights used, etc., we reply as follows: One dye house, 150 feet long, 40 feet wide and 15 feet high. In this dye house we have four lamps, which give us all the light we require. Our smalller dye house, connected with the room described by a passage way, is the same height, and 88 fett long; in this we have two lamps, making six in all. We are very much pleased with the results of this light in the dye house, particularly in the winter, when, although we often have a dense fog caused by the steam arising from the dye tubs, we are enabled to work as well, in fact much better, by night than during the day time, matching colors as well as be day light.

Yours truly,

JOS. W. CHENEY. CHENEY BROS.

HOW IT AFFECTS INSURANCE:

FROM BOSTON MANUFACTURERS MUTUAL FIRE INS. CO.

BOSTON MANUF'S MUTUAL FIRE INS. CO.,
BOSTON Mass., Nov. 21, 1879.

G. W. Stockly, Esq., V. P. Telegraph Supply Co.:

Dear Sir:—You are at liberty to say that this company prefers the Electric Light (so guarded that points of incandescent carbon cannot fall from it) to any other known mode of lighting, having as yet been unable to find any cause of danger in its use, except as above stated.

Yours very truly,

EDWARD ATKINSON, President.

It is well known that Hon. Edward Atkinson is the highest authority on mill insurance and mill matters generally, and we attach great value to his endorsement of our light.

HOW IT SUCCEEDS IN STORES.

FROM NEW YORK DRY GOODS HOUSES

345-347 BROADWAY, NEW YORK, May 5, 1880

The Brush Electric Light Company, 338 Broadway, City:

Gentlemen:—At your request, we are pleased to state that your Company have just put in our store one of your large 16-light electric machines, and have just got the lights properly adjusted. So far, we are very highly pleased with the result. We find the light to be very brilliant, clear, steady, and much softer and more pleasant for the eye than we anticipated. We believe it will be a great saving in expense, and far more cheerful than gas, and does away almost entirely with the heat that usually fills a close room from gas jets. We belive it has special adaptations and advantages for the sale of dry goods, as the most delicate tints and shades can be selected by the electric light quite as well, or even better, than by ordinary daylight, and we most cheerfully commend its use in all ordinary business in preference to gas.

BATES, REED & COOLEY.

66 and 68 WORTH STREET, NEW YORK, May 5, 1880.

The Brush Electric Light Company, 338 Broadway:

Gentlemen:—Replying to your inquiry, as to the results of our experience with the Brush Electric Light, we would say that it has given us great satisfaction in our factories and our store in this city. We esteem it far superior to any other artificial light now in use. It is much more effective than gas, as colors can be selected by the light equally as well as they can by daylight, which in dry goods is very important. The saving in factories has been great, not only in the fact that it is far cheaper than gas, but also for the reason that less imperfect goods are made.

Truly yours,

A. D. JUILLIARD & CO.

345 BROADWAY, NEW YORK, May, 5 1880.

The Brush Electric Light Company, C. M. Rowley, General Manager:

Dear Sir:—We have been using for the past three months two of your 16-light machines with much satisfaction both to ourselves and our customers. The parts of our store that were undesirable on account of darkness, are by the use of the light rendered suitable for our business.

Since the introduction of the light we are enabled on dark days, or even at night, to exhibit any and all kinds of colors of goods as satisfactorily as in clear sunlight. The apparatus requires but little attention, and we are well satisfied with its beautiful light.

Yours truly,

DUNHAM, BUCKLEY & COMPANY.

BLACK DIAMOND STEEL WORKS.

PARK, BROTHER & CO., PITTSBURGH, July 9, 1880.

Telegraph Supply Co., Cleveland, O.:

Gentlemen:--I received the copy of the Cleveland Herald containing Dockyard, England, as per statement taken from *London Times.* I am glad to learn of the success of the light wherever used. At our works all is going on nicely, and the same set of workmen, who believed and declared they could not get along without gas light, are thoroughly converted. A few times the engine driving your machines had to be stopped a minute or two, and the gas turned on, when the men declared they could not do their work at all with gas light, and when the Electric Light is turned on hail its appearance with shouts. Wishing you full and entire success in the future, and hoping you have altogether recovered from the fire,

I am truly yours,

JAMES PARK, Jr.

FROM BAY STATE IRON COMPANY.

OFFICE BAY STATE IRON CO., 2 PEMBERTON SQUARE, BOSTON.

Brush Electric Light Co, 5 Pemberton Square, Boston.

Gentlemen:—In answer to your enquiries as to the operation of the Brush Electric Light Machine at our Works in South Boston, we would say: We purchased the largest sized machine, No. 7, for eighteen lights, with single lamps; but are using at present but eight of them, constantly, which number we expect to increase at an early day. We have substituted double for single lamps, by which we get a light burning sixteen hours without change.

We use the light in all parts of our works, and have also employed it while unloading coal at night at our wharves. For all purposes and in all places where we have needed it the light has answered our expectations for economy in the power required and in the cost of production, and we consider it has special adaptations and advantages for use in all departments of the iron industry.

Truly yours,

J. AVERY RICHARDS, Treasurer.

FROM THE PHOENIX IRON WORKS.

Telegraph Supply Co., Cleveland: PHŒNIXVILLE, Pa., July 10, 1879.

Gentlemen:—We light our machine shop, 317x90 feet, 38 feet high, and our column shop, 130x53 feet, 13 feet high, with 11 Brush Electric Lights. In these shops are about 100 machines, consisting of lathes, planers, drill-presses, boring mills, punches and steam riveters. We formerly used reflector lamps and small hand lamps, costing about $11.25 per night of 12 hours. Counting power, attendance and carbons, the cost of the Electric Light is about $4.00 per night. The lights have given us satisfaction, and we consider them much better and cheaper than anything we have hitherto had, and superior to any other we know of.

Yours truly,

PHŒNIX IRON CO.

OTIS IRON AND STEEL COMPANY.

CLEVELAND, O., July 1st, 1880.

Geo. W. Stockly, Esq.:

My Dear Sir:—In regard to the Brush Electric Light which we have had in use at our works for several months, I would say that we are more than satisfied with it. We have no trouble with it either in running or taking care of it, in fact it goes like an eight-day clock. I consider it the only system by which large spaces like Rolling Mills or Steel Works can be satisfactorily lighted. In the winter our men claim they can see by it better in night than by natural light by day, but for this I would not vouch. Yours truly,

S. T. WELLMAN, Supt.

FROM NORWAY IRON COMPANY.

NORWAY IRON WORKS, BOSTON, January 20, 1880.

Brush Electric Light Co., Boston:

Gentlemen:—The number 7 machine for eighteen double lamps which you furnished us works to our entire satisfaction, giving us all the light we required at the various parts of our mill which we wished to illuminate. Truly yours,

NAYLOR & CO.

FROM POTTSTOWN IRON COMPANY.

POTTSTOWN, Pa., December 17, 1879.

Telegraph Supply Co., Cleveland, Ohio.:

Gentlemen:—Replying to your favor of the 10th inst., would say that we are using the Brush Electric Light in our plate iron works, nail manufactory and shops, very successfully. Our primary object in introducing the light in our works was to enable us to run our nail factory double turn, as the large and increasing demand for our special brand made it necessary for us to enlarge our production. The work of nailing requires a good strong light; the operating of a nail factory at night being a new departure for that branch of the iron trade; but with the aid of the Electric Light the main difficulties have been overcome, and we were so much pleased with its service that we introduced it also into our mills and shops, believing that it would add to the comfort of our men as well as increase their utility, although the same degree of light required for our factory work is not necessary for general mill operation. We have a large trade in plates for locomotive and tubular boiler purposes, as we make a specialty in the higher grades, as well also for ship plates, of which we furnished largely for the American line of steamers. The adoption of the light in this last named department has fully met our expectations, and enables us to take further steps for the increase of our product there, which the enlarged call for our plates now necessitates. Yours respectfully,

WILLIAM H. MORRIS,
Treasurer Pottstown Iron Co.

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THE GRAND PACIFIC HOTEL, CHICAGO.

Brush Electric Co., Cleveland, O.: CHICAGO, July 10, 1880.

Gentlemen:—We are using in our Hotel one of your largest sized machines for the illumination of the following rooms:

Three Electric Lights in Office, displacing 136 gas jets; two in Exchange, displacing 96 gas jets; four in dining room, displacing 110 gas jets; four in corridors, displacing 76 gas jets; two in ladies' ordinary, displacing 88 gas jets; two in parlors, displacing 64 gas jets. 570 gas jets in all, displaced by 17 Electric Lights. Our use of the Light has developed the fact that it is a perfectly practical and exceedingly economical method of lighting these parts of our house, and we estimate that by the use of these seventeen Electric Lights we save not less than $300 per month over what the gas cost us. We heartily recommend your Light for the use of hotels and similar establishments.

Yours truly,

JNO. B. DRAKE & CO.
PROPRIETORS.

FROM SENATOR WM. SHARON, OWNER OF PALACE HOTEL.

Telegraph Supply Co., S. F.: SAN FRANCISCO, April 24, 1879.

Gentlemen:—I have been using ten Electric Lights at the Palace Hotel, furnished from one No. 4 and one No. 5 Brush machine, using about ten horse-power. The lights are placed as follows: Two 3,000 candle lamps in the Court, displacing 510 gas jets; two 1,000 and one 3,000 candle lamps in the grand dining room, displacing 280 gas jets; one 1,000 candle lamp in the restaurant, displacing 150 gas jets; one 1,000 candle lamp in the office, displacing 100 gas jets; one 1,000 candle lamp in the kitchen, displacing 20 gas jets; one 1 000 candle lamp in bar room, displacing 25 gas jets; one 3,000 candle lamp in front of the hotel. The lamps in the dining room are switched from there to the front of the hotel, and to the bar room after the dinner hour, AND ALL ARE WORKING TO OUR ENTIRE SATISFACTION. We feel free to state that the Brush Electric Light is a cheap, practical light to use where much light is needed.

Yours truly,

WM. SHARON.

We also light, with equal success, the Baldwin Hotel at San Francisco. For Hotel offices, corridors, dining rooms, etc., it is especially valuable and insures a great saving over gas.

FROM THE "CONTINENTAL," PHILADELPHIA.

The Continental Hotel last evening introduced the Brush Electric Light in main hall, dining room, office and bar room. Six burners are used, at a cost of one cent each per hour. In the dining room, where one hundred and forty-four gas burners were used formerly, there are two

electric burners, which give much more light than all the chandeliers. The power is obtained from the engine which runs the elevator, and the saving to the hotel will be very great. The gas bill for one year has reached the sum of $21,000, which will be greatly reduced. The Continental is the first hotel in this city to use the Electric Light, and it is believed the example will be followed by others, as the Grand Pacific Hotel, Chicago, and Palace Hotel, San Francisco, have successfully used the Brush Light for more than a year.—*Philadelphia Times, June 6.*

MENOMINEE MINING COMPANY,

PROPRIETORS OF THE VULCAN, CYCLOPS, NORWAY, QUINNESEC, CHAPIN & FLORENCE IRON MINES, IN THE MENOMINEE RANGE.

VULCAN, Mich., May 28, 1880.

Messrs. Telegraph Supply Co., Cleveland, O.:

Gentlemen:—We have had one of your smaller six light machines in constant use in our Quinnesec Mine since last year. It has proved so reliable, and has at all times given such a steady light, that all our varied underground work has been greatly facilitated. In the labor of assorting rock from ore, we do as well underground as though working by daylight. With the eighteen light machine, which we are using in the open pits of the Norway mine, our work at night is always effective and very satisfactory.

Yours truly,

NELSON P. HULST, Sup't.

FROM THE DEER CREEK MINE, NEAR SMARTSVILLE, CAL.

SAN FRANCISCO, April 24, 1879.

Telegraph Supply Co., S. F.:

Gentlemen:—I have just returned from the Deer Creek Mine, near Smartsville, which is now lighted at night by three lanterns of 3,000 candle power each, supplied from a Brush Electric Machine furnished by you. The light thus produced enables the company to work the mine at night practically as well as by day. The machine requires but little attention, and the expense is small. Should the apparatus continue to work as well as at present the company will be entirely satisfied.

Yours truly,

GEO. P. THURSTON, Secretary.

The Lake Superior Mine at Ishpeming, and the Menominee Mine at Quinnesec, Mich., are also using our light with excellent results.

THE BERGNER & ENGEL BREWING CO., PHILADELPHIA.

PHILADELPHIA, August 26, 1880.

The Brush Electric Light Co., New York.

Gentlemen:—The Electric Light Machine you placed in our brewery some two months ago works quite satisfactorily, and the illumination of the comparatively large spaces in which the light is used, is perfect and all that could be wished for.

Respectfully yours,

GUSTAVUS BERGNER, President.

WHAT A PROMINENT MINING MAN SAYS OF IT.

OFFICE OF GREAT BASIN M. & S. CO. STOCKTON, Oct. 14, 1880.

Mr. C. C. Ruthrauff, Agent Brush Electric Light:

Dear Sir:—I have been using the two light Electric Machine, purchased from you last summer, since September 10th, and I am both satisfied and pleased with its operation. The machine is run from my regular power, and the light is brilliant, clear and beautiful, so that the men can work as well by night as by day. It is cheaper than oil, while an infinitely greater quantity of light is furnished. It requires no special attention from the engineer, and runs with perfect regularity. With this light the men cannot shirk. I would not be without it.

Respectfully yours,

P. EDWARD CONNER, Managing Director.

HARBOR LIGHTING.

HARBOR COMMISSIONERS OF MONTREAL,
CHIEF ENGINEER'S OFFICE,
MONTREAL, Oct. 7, 1880.

Brush Electric Light Co., New York:

Gentlemen:—As a reply to your inquiry regarding the apparatus used for lighting the wharves of the Harbor, I beg to quote the following from my recent Report to the Board of Harbor Commissioners:

"The Electric Light Apparatus, after some seven weeks' experience in active service, was accepted by the Board on the 28th of July, and since then has been continued in constant use and with very satisfactory results. The lamps with a single pair of carbons which were temporarily furnished at first, have been replaced by the permanent double lamps, which automatically switch the second pair of carbons into action when the first pair are consumed, and thus gives a continuous light without trimming.

"The apparatus, as it now stands, consists of one Brush Dynamo-Electric Machine, working a single circuit of 14,600 ft. or 2¾ miles in length, on which are arranged 21 lamps, any 16 or lesser number of which may be used at once on such wharves as vessels desire to handle cargoes during night, the remaining lamps being simply switched out as a gas lamp may be turned off.

"The length of the district covered by the lamps is 1½ miles, and the wharf frontage, including piers is 9,100 lineal feet, or nearly 1¾ miles, over which the light of the 16 lamps may be distributed as desired.

"The system is worthy of note as being the first known example of lighting an extensive line of wharves by electricity, and it is further very remarkable as including a single circuit, longer, by some two and a-half times than any other which is known to be in use in electric lighting."

Yours respectfully,

JOHN KENNEDY, Chief Engineer.

THOMAS DOLAN & COMPANY.

MANUFACTURERS OF WORSTED COATINGS, WOOLENS, &C.

PHILADELPHIA, January 17, 1881.

The Brush Electric Light Co.:

Gentlemen:—About a year ago we had placed in our works, as an experiment, one of your eighteen light Dynamo Machines. We have now in use, as you are aware, seven eighteen light machines, and we have much pleasure in saying that your promises have been fulfilled and our expectations more than realized. The advantages, beside the matter of economy, for such an establishment as ours, are numerous. It is like the many improvements of the age, say the telegraph, sewing machine and telephone; we did get along without it, but now that we have it, we deem it equally indispensable with any one of them for our purpose. In the matter of economy, we find that for ordinary lighting up it is much cheaper than gas, while for work that is running all night the saving is over fifty per cent, with gas at $2 per thousand cubic feet.

Respectfully,

THOMAS DOLAN & CO.
pr. C. H. Salman, Supt.

THE LIGHTING OF MONUMENTAL PARK, CLEVELAND.

FROM HON. R. R. HERRICK, MAYOR OF CLEVELAND.

MAYOR'S OFFICE CLEVELAND, O., June 27, 1879.

A. T. Whiting, Esq., 35 Devonshire St., Boston, Mass.:

Dear Sir:—Yours of the 4th instant is received. Our Monumental Park, formerly lighted by 105 gas lamps, is now and has been since sometime in April far better lighted by 12 Brush Electric Lights.

I think this Brush Electric Light is far superior to anything I ever saw before as an out-door park light. It is beautiful, and makes everything around appear beautiful. I believe our people are universally pleased with the light. It is brilliant and steady. Our heavy storms of wind and rain do not seem to effect it in the least. The machine is located 500 feet from the park, and the circuit is about 4,000 feet in length, and all the lights are in one circuit. I think Nantasket Beach would be grandly beautiful if illuminated by these lights.

Respectfully,

R. R. HERRICK, Mayor.

HORSE POWER REQUIRED.

RIVERSIDE WORSTED MILLS,
PROVIDENCE, R. I., Oct. 29, 1880.

Brush Electric Light Co., New York:

Dear Sirs:—Yours of the 7th received, and in reply we would say that we had our engine indicated by an expert from the Corliss Engine Co., on the 6th of September, 1880.

In his report he says: "During the experiment made to determine power required for Electric Lights, there were running 81 lights; 4

machines connected to 16 lights each, and one machine to 17 lights, thus making 5 machines in operation. The power required to drive the lights and machines was 63.58 horse power." Respectfully,

RIVERSIDE WORSTED MILLS.
By Herbert Wiswall.

WESTERN ENTERPRISE.

A TOWN LIGHTED BY THE BRUSH ELECTRIC LIGHT.

The city of Wabash, Indiana, makes the proud boast of being the first city in the world to adopt the Electric Light for street illumination, and its trial seems to have proved, in a double sense, a brilliant success. The Common Council of this place, a few weeks ago, entered into negotiations with the Brush Electric Light Company of Cleveland, Ohio, for one of their dynamo-electric generating machines of a guaranteed capacity of four lights of over 3,000-candle power each. These four lamps are suspended from the ends of two cross-bars bolted about half way up an iron flag staff that rises from the dome of the Court House. The Court House itself stands on a rise of ground that, with the height of the dome, gives the light an elevation of about 200 feet above the city. The generating engine of eight-horse power is located in the cellar of the building. The contract was that the lights should illuminate a circle one mile in diameter as light at the farthest point as it would be with a gas lamp of usual street size every hundred feet. The trial showed this requirement to be more than fulfilled, as it was light enough at much more than that distance to tell the time on a watch, or read coarse print. Over ten thousand people witnessed the test.

Every alley and back yard receives the light. A careful computation shows that to light the town equally as well by gas would require three lamps to every square, which would take over 500 fer the same area.

These electric lamps consist simply of two carbon pencils about half an inch in diameter, arranged so that the current passes through all four and then returns to the machine. Each lamp has two sets of these carbons, so arranged that when one set burns out the other lights automatically.

The entire apparatus furnished by the Brush Electric Light Company—lamps, wires and generating machines—cost $1,800. The engineer and fuel and entire expense of lighting the town is estimated at $750 per year, while sixty-five gas lamps, which would only make darkness visible in the same area, would cost $1,100 per year.—*Boston Daily Advertiser, May 8.*

After the above test the city of Wabash purchased the entire outfit and is regularly using it for the lighting of the town, greatly to the satisfaction and accommodation of the citizens. It is a complete practical success.

List of Users of the Brush Light.

As the best evident of the fact that the *Brush Electric Light* is no longer an experiment, but a fully developed and thoroughly practical illuminator, we give below a list of the more prominent places where the light has been purchased and is in regular use, or has been ordered for use. In none of these places was it adopted for its beauty and novelty only, but because it was the cheapest and best light obtainable and was entirely practical and simple.

In factories, mills, shops, depots, docks, parks, open spaces, warehouses, steamers, ferry boats, locomotives and in similar situations, it has no equal, and is being introduced as rapidly as our manufacturing facilities permit.

Rolling Mills, Iron and Steel Works, Machine Shops, etc.

32	Lights—	Park, Bro. & Co., Black Diamond Steel Works, Pittsburgh, Pa.
30	"	Brown, Bonnell & Co.'s mills, Youngstown, O.
23	"	Pottstown Iron Co.'s mills, Pottstown, Pa.
4	"	Edge Moor Iron Co., Edge Moor, Del.
12	"	Phoenix Iron Co.'s mills, Phoenixville, Pa.
6	"	Pennsylvania Steel Co.'s mills, Baldwin Station, Pa.
16	"	Otis Iron & Steel Co.'s mills, Cleveland, O.
2	"	Nashua Iron Co.'s mills, Nashua, N. H.
18	"	Norway Iron Co 's mills, South Boston, Mass.
18	"	Bay State Iron Co.'s mills, South Boston, Mass.
16	"	Passaic Rolling Mill Co.'s mills, Paterson, N. J.
16	"	New Jersey Iron & Steel Co.'s mills, Trenton, N. J.
6	"	Union Rolling Mill Co., Chicago, Ill.
6	"	North Chicago Rolling Mill Co., Chicago, Ill.
32	"	W. C. Allison & Co.'s car works, Philadelphia, Pa.
16	"	Washburn & Moen Manuf'g Co.'s wire mills, Worcester, Mass.
6	"	Niles Tool Works, Hamilton, O.
4	"	Union Iron Works, San Francisco, Cal.
10	"	M. C. Bullock, Diamond Drills, Chicago, Ill.
16	"	Standard Nut Co.' Pittsburgh, Pa.
6	"	Pittsburgh Hinge Co., Pittsburgh, Pa.
2	"	Falls Rivet Co., Cuyahoga Falls, O.
32	"	Albany & Rens'r Iron & Steel Co., Troy, N. Y.
16	"	Moorhead, McClean & Co., Pittsburgh, Pa.
7	"	Akron Iron Co., Akron, O.
16	"	Aultman, Miller & Co., Agricultural Works, Akron, O.
18	"	South Boston Iron Co., Boston, Mass.
16	"	J. A. Roebling's Sons' mills, Trenton, N. J.
16	"	Wm. Sellers & Co.'s works, Philadelphia, Pa.

18 Lights—Jackson & Sharp Co., Wilmington, Del.
32 " Reading Iron Works, Reading, Pa.
6 " Griffin Car Wheel Co., Detroit, Mich.
80 " Edgar Thompson Steel Co., Pittsburgh, Pa.
16 " Harrison Wire Co., St. Louis, Mo.
16 " Joshua Rhodes & Co., Allegheny, Pa.
15 " Deere & Co., Plow Works, Moline, Ill.
18 " Blain Bros., Huntingdon, Pa.
16 " Sweets' Manufacturing Co., Syracuse, N. Y.
16 " D. M. Osborne & Co., N. Y.
16 " Hussey, Howe & Co., Pittsburgh, Pa.
16 " Lackawanna Iron & Coal Co., Scranton, Pa.
16 " Cambria Iron Co., Johnstown, Pa.

Woolen, Cotton, Linen and Silk Factories.

126 Lights—Thomas Dolan & Co.'s woolen mills, Philadelphia, Pa.
116 " Riverside Worsted Mills, Providence, R. I.
108 " Oswego Falls Woolen Mills, Fulton, N. Y.
116 " Atlantic Mills dress goods, Providence, R. I.
54 " Amoskeag Manufact'g Co., cotton goods, Manchester, N. H.
65 " Willimantic Linen Co., spool cotton, Wilimantic, Conn.
54 " Eagle and Phoenix Mills, Columbus, Ga.
32 " Mississippi Mills, Wesson, Miss.
20 " Globe Mills, dress goods, Woonsocket, R. I.
36 " Conant Thread Co., spool cotton, Pawtucket, R. I.
18 " Moss Manufacturing Co., Westerly, R. I.
6 " Waterman & Meyer, corset factory, W. Brookfield, Mass.
18 " Cheney Bros., silk works, South Manchester, Conn.
18 " Raritan Woolen Mills, Raritan, N. J.
36 " Cohannet Mills, Taunton, Mass.
72 " Whittenton Manufacturing Co., Taunton, Mass.
72 " Wanskuck Co., Providence, R. I.
58 " Burlington Woolen Mills, Winooski Falls, Vt.
18 " Renfrew Manufacturing Co., North Adams, Mass.
18 " Walcott & Campbell New York Mills, Utica, N. Y.
18 " Chicopee Manufacturing Co., Chicopee Falls, Mass.

Large Stores.

64 Lights—John Wanamaker, Grand Depot, Philadelphia, Pa.
20 " Dunham, Buckley & Co., dry goods, 340 Broadway, N. Y.
36 " Bates, Reed & Cooley, dry goods, 343 Broadway, N. Y.
6 " A. D. Juilliard & Co., dry goods, 68 Worth street, N. Y.
6 " Loeser & Co., dry goods, Brooklyn, N. Y.
6 " Continental Clothing House, Washington St., Boston, Mass.
40 " S. C. Davis & Co., dry goods, St. Louis, Mo.
56 " Willoughby, Hill & Co., clothing store, Chicago, Ill.
6 " Jevnes Tea Store, Chicago, Ill.
6 " A. J, Nutting & Co., clothiers, Brooklyn, N. Y.
6 " John Paret & Co., clothiers, Brooklyn, N. Y.
16 " H. K. & F. B Thurber & Co., New York City.
16 " Wm. Whitney & Co., dry goods, Albany, N. Y.
7 " E. M. McGillen & Co., dry goods, Youngstown, O.
6 " E. M. McGillen & Co., dry goods, Cleveland, O.

Parks, Docks, Summer Resorts, etc., for Out-door Use.

17 Lights—Prospect Park, American Falls, Niagara Falls, N. Y.
17 " Chautauqua S. S. Assembly, Fairpoint, N. Y.
16 " Monumental Park and Superior street, Cleveland, O.
16 " Nantasket Beach, Boston Harbor, Boston, Mass.
18 " N. O. City Ry. Co.. gardens. New Orleans, La.
18 " Schwartz Bros., gardens, New Orleans, La.
18 " Brighton Beach Hotel, seaside resort, Coney Island, N. Y.
17 " Harbor of Montreal and docks, Montreal Canada.
16 " Atlantic Garden, Bowery, New York City.
18 " Sea Beach Palace Hotel, Coney Island, N. Y.
4 " Henry Wenzer, New Orleans, La.
40 " Jockay Club, New Orleans, La.

Circuses,

13 Lights—Cooper, Bailey & Co., London Circus, "On the Road."
9 " W. W. Coles' circus, "On the road."
4 " John Robinson's circus, "On the road."
2 " W. C. Coup's circus, "On the road."

Colleges, Churches, etc.

2 Lights—Franklin Institute, Philadelphia, Pa.
2 " Ohio Medical College, Cincinnati, O.
1 " Wabash College, Crawfordsville, Ind.
2 " Baptist Church, North Orange, N. J.

Hotels,

10 Lights—Palace Hotel, San Francisco, Cal.
10 " Baldwin Hotel, San Francisco, Cal.
18 " Grand Pacific Hotel, Chicago, Ill.
16 " Continental Hotel, Philadelphia, Pa.
16 " Sherman House, Chicago Ill.

Railroad Companies.

18 Lights—C. & N. W. Ry. Co., Ore Docks, Escanaba, Mich.
16 " Manhattan Co. Elevated Roads, New York City.
36 " Penna. R. R. Depot, Jersey City, N. J.
16 " Penna. R. R. Shops, Altoona, Pa.
18 " Mich. Cen. R. R. Co., Detroit, Mich.
72 " Boston & Albany R. R. Co., Boston, Mass.
6 " Grand Trunk R. R., Montreal, Canada.
6 " Galveston City, R. R. Co., Galveston, Texas.

Mines, Smelting Works, etc.

6 Lights—Menominee Mining Co., Quinnesec Mine, Quinnesec, Mich.
18 " Menominee Mining Co., Norway Mine, Vulcan, Mich.
18 " Cleveland Iron Mining Co., Cleveland Mine, Ishpeming, Mich.
4 " Deer Creek Mine, near Smartsville, Cal.
16 " Pilot Knob Iron Co., iron mine, Pilot Knob, Mo.
2 " Great Basin Mining and Smelting Co., Salt Lake City, Utah
2 " Old Jordan Mining Co., Salt Lake City, Utah.
4 " North Bloomfield Mining Co., Nevada City, Nevada
14 " Alice Gold & Silver Mining Co., Walkerville, Montana,
12 " Calumet & Hecla Mining Co., Calumet, Mich.

3 Lights—Bassick Silver Mining Co., Rosita, Colorado.
4 " Horn Silver Mining Co., Frisco, Utah.
6 " Billing & Eilers, Smelters, Leadville, Col.
7 " Grant Smelting Works, Leadville, Col.

Steamers.

6 Lights—Steamer Massachusetts, Providence Line, N. Y. City.
3 " " R. R. Springer, Mississippi River, Cincinnati, O.
6 " " State of California, Pacific C. Line, San Francisco, Cal.
2 " " R. C. Grey, Grey's Iron Line, Pittsburgh, Pa.
2 " " Iron Dale, Grey's Iron Line, Pittsburgh, Pa.
6 " " Anchor Line Steamers, St. Louis, Mo.
6 " " S. H. Parisot, New Orleans, La.
2 " " Natchez, Captain Leathers, New Orleans, La.
3 " " J. K. White, New Orleans, La.
1 " " Harry Brown, Pittsburgh, Pa.

Factories and Establishments of Various Kinds.

20 Lights—Barber Match Co., match factory, Akron, O.
16 " Allen Bro., paper mill, Sandy Hill, N. Y.
2 " Montague Paper Co., paper mill, Turner's Falls, Mass.
19 " Stanley Rule and Level Co., N. Britain, Conn.
6 " Plume & Atwood Manufacturing Co., Thomaston, Conn.
4 " Atlantic Petroleum Refining Co., Point Breeze, Philadelphia.
1 " Hartford Steam Boiler Inspection Co., Philadelphia.
4 " American Linoleum Co., Staten Island.
32 " Chicago Times Building, Chicago, Ill.
1 " Chicago & Alton Railroad bridge, Glasgow, Mo.
40 " Crystal Plate Glass Co., Crystal City, St. Louis, Mo.
16 " J. G. Kitchen, Philadelphia.
18 " Ferry Seed Co., Detroit, Mich.
3 " Olds & Lord, saw mill, Afton, Minn.
6 " Bergner & Engle Brewing Co., Philadelphia.
12 " Planters Oil Co., New Orleans, La.
3 " Pack, Woods & Co. Lumber Mill, Oscoda, Mich.
18 " Studebaker Bros. Manufacturing Co., South Bend, Ind.
16 " Cincinnati Cooperage Co., Cincinnati, O.
16 " Fleischman & Co., Cincinnati. O.
16 " Strobridge Lithograph Co., Cincinnati, O.
16 " G. Y. Smith & Co., Kansas City, Mo.
1 " Spencer Borden, Fall River, Mass.
16 " Dickson Manufacturing Co., Scranton, Pa.
16 " Walter Aiken, Franklin Falls, N. H.

Rented Lights Furnished from a Central Station.

71 Lights—California Electric Light Co., San Francisco, Cal.
36 " Grand Rapids Electric Light and Power Co., G'd Rapids, Mich.
32 " Detroit Electric Light Co., Detroit Mich.
296 " Brush Electric Light Co., Lighting Station, New York City.
4 " City of Wabash, on Court House dome, Wabash, Ind.
8 " City of Akron, O., City Lighting.
105 " Salt Lake City, Utah, Lighting Station.
4 " Ogden, Utah, City Lighting.
48 " Lighting Station, Cleveland, O.

100 Lights—Lighting Station, Cincinnati, O.
200 " Lighting Station, Denver, Col.
100 " Lighting Station, Dayton, O.

Foreign Use of Brush Light.

1,000 Lights sold for British Royal Navy, London, England, and to various other parties by Angio American Electric Light Co., London, England. Among which we mention the following:

The Admiralty, for Royal Navy.
South Kensington Museum.
Royal School of Mines, Jermyn-street.
Woolwich Arsenal.
Peek, Frean & Co., London.
Barrow-in-Furness Ship Building Company.
Great Eastern Railway Company.
Denny Bros., Dumbarton (for ships).
Messrs. Bass & Co., Burton-on-Trent.
Isaac Holden, Esq., Oakworth House, Oakworth.
Bullock & Co., (for export)
Messrs. Holden & Son, Alston Works, Bradford.
L. S. Crossley, Esq., Halifax (on order).
Messrs. Caird & Co., Greenock.
R. Napier & Sons, Glasgow (on order).
Baldwin, Halifax (on order).
Great Western Railway Company, Paddington Station (on order).
South Eastern Railway (Charing Cross Station).
Clock Tower, Houses of Parliament, Westminster.
The Roanhead Hæmatite Mines, Ulverston.
The Clyde Spinning Company, Glasgow.
Corporation of the City of London, for lighting of Blackfriars Bridge, New Bridgestreet, Ludgate Circus, Ludgate Hill, St. Paul's Churchyard (North Side), and in Cheapside (to King Street).

PRICE LIST.

PRICES OF LIGHT MACHINES.

Nos	Nominal Candle Power of Each Light.	Price.	Number of Lights.	Horse Power Required.	Weight.	Revolutions Per Minute.	Size of Pulley. Inches.	Width of Belt. Inches.
2	1500	$ 375	1	1½	260	1100	5	3
3	3000	500	1	2	400	1075	6	3
4	2000	675	3	3	550	1050	6	4
5	3000	1200	4	6	1150	900	10	4½
5	2000	1200	6	6	1150	900	10	4½
7	2000	2000	16	14	2500	750	14	8
8	2000	3600	40	36	4800	700	20	12

The candle power of Lights is measured by the French method, with the carbons in their best position, and is the maximum light they will yield.

Above prices are for machines alone, exclusive of lamps.

Dial attachment for use with No. 7 machines....................$125 00
Dial attachment for use with No. 8 machines.................... 200 00

PRICES OF LAMPS.

NOS.
2. Hanging Lamps, single....................................$ 65 00
3. Hanging Lamps, double, for all night use.................... 80 00
4. Ornamental Lamps, single.................................... 80 00
5. Ornamental Lamps, double, for all night use.................. 95 00
6. Headlight Lamps, single..................................... 85 00
   22 in. Parabolic Reflector & Case, for use with Headlight Lamps 50 00
   Special Flat Reflector and Case, for use with Headlight Lamps. 60 00
7. Focusing Lamps, for projections, etc......................... 75 00
8. Dye House Lamps, single...................................... 80 00
9. Special Lamps for Mines...................................... 70 00
10. Special Outdoor Lamp, single................................ 65 00
11. Special Outdoor Lamp, double................................ 80 00

CARBONS.

Carbons (coated with copper under the Brush patent) 12 inches long, 7-16 inch diameter, per hundred..............................$ 6 25
Special sizos to order.

Each lamp will consume from 1½ to 2 inches of carbon per hour, costing *one cent.*

PRICES OF ELECTRO-PLATING MACHINES.

NOS.
2. Nine inch Armature, requires 1½ H. P........................$375 00
3. Eleven inch Armature, requires 2 H. P....................... 600 00
4. Twelve inch Armature, requires 3 H. P....................... 800 00

The above Plating Machines are furnished with counter-shaft, cone pulleys and a resistance-switch, without extra charge.

ALL PRICES GIVEN ABOVE ARE NET. CASH IN THIRTY DAYS.

THE BRUSH ELECTRIC LIGHT.

THE

BRUSH SYSTEM OF ELECTRIC LIGHTING,

By Charles F. Brush, M. E.

PECULIAR FEATURES OF THE DYNAMO-ELECTRIC MACHINE.

The most prominent peculiarities of the Brush dynamo-electric machine are embodied in the armature, the arrangement of field magnets, and the commutator.

The armature consists of a flat ring of soft cast-iron, revolving in its own plane. This ring is composed of two or more parts, each provided with a series of grooves, and insulated from each other, all in such a manner as effectually to prevent the induction of currents in the iron itself when it is revolved in a magnetic field. On this ring are wound eight bobbins of armature conductor, whose planes radiate from the axis of rotation.

The field magnets of the machine face both sides of the armature, in the plane of its rotation; thus both sides of the flat bobbins of armature conductor are exposed to the direct inductive influence of the magnets. This arrangement of armature and magnets differs radically from that adopted in the Gramme machine, the only other dynamo-electric machine of note in which an annular armature is employed.

Field magnets of opposite polarity are applied to diametrically opposite points of the annular armature, which then consists practically of two semi-circular magnets, having their like

poles joined. Each of these semi-circular armature magnets, if straightened out, would be much longer than its own diameter, and would have its bobbins wound at right angles to its axis, and covering the greater part of its length. Now it will be evident, that with a given length and weight of armature conductor, a very much greater number of convolutions may be formed on such an armature, than would be possible on other armatures whose length from pole to pole, is short compared with their diameter. But inasmuch as the field magnets are applied to both sides and very nearly the whole length of the long armature, the magnetic field in which the bobbins of conductor move, is quite as intense as that obtainable when any other form of armature is employed, and perhaps more so; hence the electro-motive force of current obtainable with an armature conductor of given resistance is, *ceteris paribus*, very much greater with this form of armature than with any other. For a practical demonstration of this let us consider the Brush machine known as size number 7. In this machine the resistance of the armature conductor, measured through the brushes on the commutator (the resistance is the same in all positions of the commutator), is about four ohms; in some machines a trifle more, in others a trifle less, according to the purity of the copper wire employed. When the armature is rotated at its normal speed of seven hundred and fifty revolutions per minute, in its normal magnetic field, the electro-motive force developed in its conductor is sufficient to maintain its normal volume of current through an external resistance, including the field magnets of the machine, of fully eighty ohms; or through a resistance twenty times as great as its own. No other form of dynamo-electric machine has yet shown a result comparable with this.

This current operates from sixteen to eighteen powerful electric lights arranged in a *single circuit*, giving to each an arc of about two millimeters length. The resistance of these arcs averages about four and a half ohms each, as shown by

many careful measurements of different lamps, both singly and in groups. (The measurements included the magnet helix of each lamp, the resistance of which is, however, quite small and will be given further on.)

The bobbins of wire on the armature of the Brush machine are not connected together in a single circuit, but each pair of diametrically opposite bobbins only, are connected together. The two free ends of the conductor thus formed of each pair of bobbins, are carried to the commutator and attached to diametrically opposite segments thereon, which segments are not connected with any other bobbins. Thus each pair of bobbins is entirely independent of any other pair.

In this arrangement, which secures important advantages, the Brush machine again differs radically from the Gramme, and all similar continuous-current machines.

The commutator consists of four separate rings of metal, each ring consisting of two nearly semi-circular segments, whose ends, on one side, are separated by a considerable space. This space is occupied by a piece of metal attached to an adjoining ring, and known as an "insulator." It is insulated by an air space from each of the segments between whose ends it is located, the other ends of the segments being simply separated by a single air space. The office of the "insulator" is to separate either of the brushes which collect the currents from the commutator, from both segments during a certain interval, and twice in each revolution of the commutator. During these separations, the two bobbins of wire on the armature which are connected with the pair of segments, are not only out of the general circuit, but are open circuited themselves, so that no current can circulate in them.

Each pair of bobbins on the armature is thus provided with a commutator ring, and the segments of this ring occupy the same angular position with regard to other segments, that its bobbins occupy with regard to bobbins attached to the said other segments.

It will now be seen that only one pair of armature bobbins is out of the general circuit at one time; and this is made to occur when the said bobbins are at and near the neutral points of the armature, and are not in a condition to contribute to the general current. Now, if it were not for the "insulators" above described, the idle bobbins would afford an easy passage for the current from the active bobbins, and thus destroy the efficiency of the apparatus.

The Gramme form of commutator, which is employed for the production of continuous currents in all machines other than the Brush, involves serious disadvantages, from which the Brush form of commutator is free. The principal difficulty arising from the use of the former is this:—The bobbins of wire, when at and near the neutral points of the armature, contribute little or no useful effect; but the current from the other bobbins must pass through them in order to reach the brushes, thus experiencing a considerable and entirely useless resistance, and, owing to the opposite directions of the currents through the active bobbins on opposite sides of the neutral points, these currents, by passing through the idle bobbins, tend strongly to produce "consequent" points in the armature where the neutral points should be; thus interfering seriously with the proper distribution of the armature's magnetism.

It may be argued that the evil above indicated is eliminated by allowing each of the brushes to embrace several sections of the commutator, corresponding to bobbins on both sides of each neutral point; this is no doubt true to some extent, but another, and perhaps worse evil is thus introduced; the bobbins corresponding to the commutator sections embraced by each brush, are short circuited in themselves, through the brush, and, owing to their comparatively small resistance, powerful currents are developed in them. These currents absorb much motive power in their production, and rapidly heat the bobbins.

Again, during each revolution of the Gramme commutator, each brush must break and make again, as many contacts as there are sections of the former, and each act involves the whole current; while with the Brush commutator, only two contacts and breaks occur with each brush in each revolution, and these successively in the different rings, so that but one-fourth of the whole current is involved at one time.

Further, the use of oil for lubrication, appears to be impracticable with the Gramme form of commutator, while it may always be employed on the Brush commutator with great advantage. Thus the durability of this commutator is made immensely greater than that of the other.

When necessary, the wearing segments of the commutator may be replaced by duplicate pieces in a very few minutes by any mechanic.

PECULIAR FEATURES OF THE LAMPS.

These are:—very great simplicity of construction; ensuring ease of management, safety against internal derangement, and securing great regularity of working:—the double magnet circuit conveying currents of opposite direction, by means of which any number of lamps may be operated in a single circuit without any irregularity of action:—the short-circuiting safety attachment, by which any lamp offering an abnormally great resistance, owing to the final consumption of its carbons, or other cause, will, without any change of strength in the main current, automatically short-circuit the said lamp, and thus preserve the integrity of the general circuit:—the multiple sets of carbons, burning successively, without the intervention of any switching or other special mechanism, and yet securing the maintainance of the light for any desirable length of time without requiring attention; lastly, the absence of any adjustment to be made by the attendant, other than placing the carbons.

These lamps contain no clock-work or similar mechanism of any kind. The movement of the upper carbon, actuated by gravity, is controlled by a simple annular clamp which surrounds the rod carrying the carbon. When the lamp is in operation, one side of this clamp is lifted by magnetic action: this causes it to grasp and raise the rod, and thus separate the carbons. As the carbons burn away, the magnetic action diminishes, and the clamp and rod move gradually downward, maintaining only a proper separation of the carbons; but when the tilted annular clamp finally touches the supporting floor from which it started, any further downward movement will at once release the rod and allow it to slide through the clamp, until the latter is again brought into action by the increased magnetism due to the shortened arc between the carbons. In continued operation, the normal position of the clamp is in contact with its lower support, the office of the controlling magnet being to regulate the sliding of the rod through it. If, however, the rod accidentally slides too far, it will instantly and automatically be raised again, as at first, and the carbon points thus maintained in proper relation to each other.

Each magnet helix is first wound with a few layers of coarse wire, through which the main portion of the current operating the lamp passes. Over this coarse wire is wound a very much greater length of fine wire, having its ends connected with the terminals of the lamp, but in such a manner that the electric current shall pass through it in a direction opposite to that in the coarse-wire helix. Thus the fine wire forms a secondary circuit of high resistance through the lamp, which circuit is independent of the arc between the carbons, and is always closed. It follows from the difference in direction of the current in the two helices, that the fine-wire helix will constantly tend to neutralize the magnetism produced by the coarse-wire or principal helix. The number of convolutions of the fine-wire helix and its resistance, are so

proportioned to the number of convolutions in the principal helix, and its resistance together with that of the normal voltaic arc, that the magnetizing power of the latter shall be much greater than that of the former. Notwithstanding the small amount of current which passes through the fine-wire helix, (about one per cent. of the whole current) its magnetic power is very considerable, owing to its great number of convolutions.

Now when a number of regulators provided with these double helices are operated in a single circuit, great uniformity of action will be maintained owing to the peculiar function of the secondary helix. Thus, when any lamp gains more than its normal arc, the resistance of its main circuit is thereby increased; more current is consequently shunted through its secondary helix, and the resultant magnetism is diminished, allowing the carbons to approach. On the other hand, if an arc becomes too short, its resistance is reduced, and less current is shunted through the corresponding secondary helix; consequently the working magnetism in that lamp is increased, and its carbons are drawn further apart. Thus it will be seen that, although the general strength of the current operating a large number of these lamps does not vary, each lamp performs its regulating functions through the agency of varying magnetism, precisely as though it were the only lamp being operated.

In practice, the resistance of the fine-wire helix or helices in each lamp is rather more than four hundred and fifty ohms; while the resistance of the coarse wire, various connections, carbons, and voltaic arc, in each lamp used with the sixteen-light machine, is about four and a half ohms. Hence not more than one per cent. of the whole current is diverted from the arc. The resistance of the coarse-wire helix, carbons, (copper-coated) connections, etc., in each lamp is very small. To determine this resistance, sixteen lamps were connected in series in the usual manner, about two hundred feet of number ten cop-

when the electric current first passes through such a lamp, the two sets of carbons, having their members in contact, will divide the current between them; but as soon as the members of one set are separated by the action of the magnet, the whole current is thrown through the other set without showing any spark between the members of the set first separated. When the continued action of the magnet separates the remaining pair of carbons, the voltaic arc appears, and the light is established. It must now be evident that the clamp which was the last to raise its rod, will be the first to release it when a forward movement of the carbons becomes necessary. Hence, the set of carbons which first commenced to burn, will continue to do so until consumed; the other set remaining separated as at first. But when the burning carbons are exhausted, and can no longer move forward, any further effort of the magnet to feed them, will at once bring the reserve set of carbons into contact; the whole current will then pass through this set, leaving the other carbons without current, and permanently separated. The reserve set of carbons will now be separated by the magnet, and burn continuously. In practice, the transfer of the voltaic arc from one set of carbons to the other, is accomplished instantaneously and is scarcely noticeable.

It will be seen that this simple arrangement cannot possibly fail in its function, there being no switch to get out of order, or contact surfaces to become burned: further, that it is perfectly automatic, and operates at the instant a change becomes necessary, and not sooner.

By means of these double-rod lamps, a system of lights may be maintained in continuous operation sixteen hours without requring any attention. This is sufficient for the longest winter night. But by introducing three rods, and three sets of carbons in each lamp, the lights may be maintained quite as easily and certainly for twenty-four hours. In this case the clamps

lift their rods successively, and feed them in the reverse order, as before.

A notable feature of the Brush lamps is the absence of any adjustment requiring the attention of the user; he has but to insert the carbons, and the lamps are always ready for action.

RESULTS ATTAINED.

On August 22d, 23d and 25th, 1879, a system of very careful measurements, both electrical and dynamic, were made by thoroughly competent persons for the purpose of accurately determining the efficiency of the Brush machine and lamps. These measurements were made at the works of the Telegraph Supply Co., Cleveland. The machine used was of the size known as No. 7; its individual mark, distinguishing it from other machines of the same class, being "Y." This machine differed in no respect from others of the same size, and there is no reason to suppose that its performance was above or below the average. Sixteen lamps of the usual pattern were employed, with about two hundred feet of copper line wire No. 10.

The machine was driven by a "Buckeye" engine with automatic cut off, running at a speed of 157 revolutions per minute. This gave to the machine an average speed, during all of the experiments, of 770 revolutions per minute. The normal speed of these machines is 750 revolutions per minute, at which speed they operate sixteen lamps normally, giving to each an arc of about two millimeters length. At the speed at which these measurements were made, the sixteen arcs were perceptibly lengthened, and, of course, more than the normal amount of driving power was required. But as this produces a nearly corresponding increase of current, no attempt was made to bring the speed nearer to the normal point, because of the difficulty of changing the speed of the engine.

The machine being entirely new, the bearings heated considerably. Some driving power must have been wasted on this account.

The first electrical measurements made, were for the purpose of determining the difference of potential existing at the terminals of each lamp. This was done by a method devised by the writer. A battery of 48 small Daniell's cells was constructed on the "gravity" plan, carefully insulated, and freshly charged with sulphates of copper and zinc to insure normal action. The sixteen lamps having been adjusted to furnish arcs as nearly equal as possible, the positive terminal of one lamp was connected with the positive terminal of the battery; while the negative terminal of the same lamp was connected with the negative end of the battery, a very sensitive galvanometer being interposed. Now, it is evident that if the difference of potential between the ends of the battery is greater than that between the terminals of the lamp, current will circulate in its normal direction through the battery, and will be indicated by the galvanometer; but if this potential is less than that of the lamp, current will also flow through the battery, but in a reverse direction, and will also be indicated by the galvanometer; while if the potential is the same in both, no current will pass in either direction through the battery, and the galvanometer will show no deflection.

As was expected, the potential of the battery proved to be higher than that of the lamp. By means of a simple arrangement, any number of the battery cells could be included in the circuit at pleasure. Such a number was chosen that the galvanometer indicated no current, or currents fluctuating from zero, equally in both directions. The appearance of the arc in the lamp was then carefully noted, and the speed of the machine counted. From time to time the condition of the arc would change slightly, or the speed of the machine would vary a little, and then more or less battery would be necessary to effect the balance. When such changes occurred, another set of observations was made as before, and so on, until results corresponding to the average working of the lamp were secured. The

large number of observations made, sufficiently eliminated the error due to the fact that no fraction of a single cell of the battery could be used in the experiments. This method of measuring the difference of potential between the terminals of the lamp, proved to be extremely satisfactory and certain in its operation; the addition or subtraction of a single cell of battery being sufficient to deflect the galvanometer needle strongly to the right or left.

A series of observations was thus made on each of eleven of the sixteen lamps, selected at random, and as the results obtained from the various lamps agreed very closely, it was deemed unnecessary to carry the process further.

The difference of potential between the terminals of the *average* lamp was thus found to be equal to that of 42.46 cells of the battery, at an average speed in the machine of 770 revolutions per minute.

The next point to be determined was the resistance of the average lamp. For this purpose a resistance consisting of coils of coarse copper wire was substituted for one of the lamps, and made of such amount that 42 cells of the battery exactly balanced the difference of potential between the two ends of the resistance, while the speed of the machine was 770. This resistance wire weighed nearly seven hundred pounds, and was but slightly warmed during the experiment. Its resistance was then *immediately* measured, with much care, before any appreciable cooling could take place, and was found to be 4.51 ohms. From this resistance, balancing 42 cells of the battery, the resistance of the average lamp, corresponding to 42.46 cells of battery, is easily deduced, and is found to be 4.56 ohms. This, multiplied by sixteen, the number of lamps in circuit, gives the total resistance of the lamp circuit,—72.96 ohms. The resistance of the conducting wires between the machine and lamps was not measured, being so small as to be unimportant. The average total internal resistance of the

machine, measured through the brushes, with the commutators in various positions, and all of the conductors warm from active use, was found by careful measurement to be 10.55 ohms. Variations of only about .02 ohm were observed when the commutator was turned in different positions. This resistance, added to that of the lamps, gives a total normal internal and external resistance of 83.51 ohms, 87.36 per cent. of which (72.96 ohms) is external. Hence, 87.36 per cent. of the current developed by this machine, is available for external work.

We have found that the electro-motive force of the current overcoming a resistance of 4.56 ohms, (the resistance of one lamp), is equal to that of 42.46 cells of battery; hence the total electro-motive force of the current, overcoming the total resistance, is

$$\frac{42.46 \times 83.51}{4.56} = 777.59 \text{ cells.}$$

Assuming the electro-motive force of each cell of battery to be 1.079 volts, the electro-motive force is, $777.59 \times 1.079 = 839.02$ volts. By Ohm's well-known formula, the current in circulation is

$$\frac{839.02}{83.51} = 10.04 \text{ webers.}$$

We have next to determine what portion of the energy of the whole current was utilized in the sixteen voltaic arcs, for the development of heat and light. To this end, the resistance of the sixteen lamps, including all connections, magnet wires, carbons, etc., minus the resistance of the arcs, was determined in the manner already described, and found to be 2.1 ohms. This, subtracted from the total resistance of the lamps, 72.96 ohms, leaves 70.86 ohms as the resistance of the sixteen arcs. This is 84.85 per cent. of the resistance of the entire circuit: and as the work performed by the current in any part of the circuit is directly as the resistance of the said part, it would appear that 84.85 per cent. of the entire energy of the

current was expended in the arcs. But this is not the case, because 1 per cent. of the current passing through each lamp is diverted from the arc by the fine-wire adjusting helices as before explained. Deducting 1 per cent. of 84.85, we have left 84., expressing the percentage of the entire energy of the current, appearing as heat and light in the arcs.

The electrical measurements above described, were made in the presence, and with the assistance of Mr. G. H. Wadsworth, Chief Operator and Electrician of the Western Union Telegraph Co.'s Cleveland Office.

The instruments used in measuring resistances, were a tangent galvanometer by Phelps, and a set of standard resistance coils rating from .01 ohm upward. The measurements were made by substitution.

During the progress of the electrical measurements above described, a system of careful measurements of the driving power absorbed by the machine was also made. This was done by Mr. Isaac V. Holmes, of Cleveland, a gentleman widely known as a mechanical engineer and expert. His measurements were made from indicator diagrams taken at the cylinder of the engine, and covered a period of about three hours.

The following table embodies the results obtained by Mr. Holmes:

Total power developed with the 16 light machine at 770 revolutions "closed,"	18.73 H. P.
Less friction load of engine "light,"	2.44 "
" " due to increase of load (18.73—2.44=16,29) at 5 per cent	.81 "
Total power absorbed by 16 light machine at 770 revolutions "closed,"	15.48 "

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Total power developed with the 16 light machine at 770 revolutions "open."	4.23 H. P.
Less friction load of engine "light."	2.44 "
" " due to increase of load (4.23—2.44=1.79) at 5 per cent	.09 "
Total power absorbed by 16 light machine at 770 revolutions "open."	1.70 "

Total power absorbed by 16 light machine at 770 revolutions, in the production of current, (15.48—1.70)............ 13.78 H. P.

NOTE—The terms "closed" and "open" refer to the external circuit of the machine. Thus, when the machine was "closed," it's current was working through the normal external resistance—that of the sixteen lamps. When "open," no current was generated.

These results agree very well with those obtained by other engineers with other machines of the same size and style. On February 6th, 1879, Mr. Noah R. Harlow, of the Lowell Water Power Co., measured the power absorbed by one of these sixteen light machines located in the Merrimack Print Works, Lowell, Mass. The speed of the machine averaged about 747 revolutions per minute while operating sixteen normal lights, and the total power absorbed under these circumstances was found to be 13.86 horse-power, including friction of dynamometer employed.

On March 18th, 1879, another machine was measured at the Dry Goods Depot of John Wanamaker, Philadelphia, Pa., by Wm. Lee Church, of the Buckeye Engine Co., of New York. Mr. Church employed the method of indicator diagrams, and obtained as a result 13.5 horse-power for the total power absorbed by the machine when operating sixteen lights. The speed of the machine was not given in his report, but was presumably about 750 revolutions per minute, as he was aware that this was the speed at which the machine should be run.

The higher results obtained by Mr. Holmes may be attributed to the increased speed at which his machine was driven, and the abnormal friction at the journal bearings, due to their newness.

Referring to the electrical measurements already described, we find that we have a current of 10.04 webers, with a total resistance of 83.51 ohms. Now the value in foot pounds of any current, is $C^2Rt \times .737335$; wherein C is the current in webers, R the total resistance of the circuit in ohms, t the time in seconds, and .737335 the equivalent in foot pounds of one

weber per ohm per second. Hence, the value in foot pounds per minute, of the current from the sixteen light machine is: $10.04^2 \times 83.51 \times 60 \times .737335 = 372410.58$. This, divided by 33,000 = 11.285, which is the energy of the current expressed in horse-power. Again,

$$\frac{11.285}{15.48} = .729;$$

hence, 72.9 per cent. of the total power applied at the pulley of the machine was converted into current. We have already found that 84 per cent. of the entire energy of the current appeared in the voltaic arcs. Multiplying 72.9 by .84 we have 61.24 as the percentage of the total driving power appearing in the arcs.

If we deduct friction and resistance of air from the gross power absorbed, and consider only the power actually absorbed in the production of current, as is usually done in determining the efficiency of dynamo-electric machines, we have,

$$\frac{11.285}{13.78} = .8189;$$

or 81.89 per cent. of the absorbed power converted into current. As before, 84 per cent. of this current appearing in the arcs, we have $81.89 \times .84 = 68.79$ per cent of the entire power absorbed in the production of current, present as heat and light in the sixteen arcs.

RECAPITULATION.

Resistance of dynamo-electric machine	10.55 ohms.
" " external circuit	72.96 "
Total resistance of circuit	83.51 "
Resistance of 16 voltaic arcs	70.86 "
Percentage of current available for external work	87.36
Percentage of current appearing as heat and light in 16 voltaic arcs	84.00
Electro-motive force of current	839.02 volts.
Volume of current	10.04 webers

Total driving power required..............................	15.48 H. P.
Driving power absorbed in production of current..........	13.78 "
Energy of current expressed in horse-power...............	11.285 "
Percentage of gross power converted into current.........	72.90
Percentage of absorbed power converted into current.....	81.89
Percentage of gross power appearing in arcs.............	61.24
Percentage of absorbed power appearing in arcs..........	68.79

These results require no comment. Their excellence is apparent. They have not yet been approached by those of any other dynamo-electric apparatus operating multiple lights; or even by those operating single lights.

Mr. Louis Schwendler, in his excellent "Report on the results obtained by the *electric light experiments*," dated London, Nov. 1st, 1878, gives the percentage of absorbed power appearing in the electric lamp, in the cases of four dynamo-electric machines. The lowest result given was 30, and the highest 62 per cent.; the latter with a machine of the Siemens type. This is much the highest efficiency we have yet seen reported authentically, of any dynamo-electric machine. The result was obtained only under the most favorable circumstances, as pointed out by Mr. Schwendler, viz.: with a machine furnishing a single light, and developing a large volume of current (29.5 webers), of comparatively low electro-motive force.

The Brush machine, developing a much smaller volume of current, of a vastly greater electro-motive force, and operating sixteen lights, yet shows a much higher efficiency viz.: 68.79 per cent.

From the peculiar nature of the Brush system of lighting, arise very important advantages over other systems, not yet touched upon. We refer to the great ease with which the lights may be operated a long distance from the dynamo-electric machine, and the small loss of effect occasioned by so doing.

When a separate dynamo-electric machine is employed for each light, according to the systems which appear to be most in favor in England and France, or when the same machine

furnishes several currents, each operating a light, then each lamp must be independently connected with the machine, and the whole loss of current occasioned by the resistance of the pair of conducting wires, must fall upon each single lamp. There must also be as many complete sets of conductors as there are lamps.

In the Brush system, one pair of conductors is sufficient for all the lamps, no matter what their number may be; and the loss due to these conductors falls not on each lamp, but is equally divided between all. Hence, in order to reduce the loss in each light due to the conductors in the single-light system, to the same amount as that in each light in the multiple-light system, the size of the conductors in the former case must be to that of the conductors in the latter case, directly as the number of lights operated in the multiple-light system, to unity. And, since the single-light system requires as many sets of conductors as there are lamps, while the multiple-light system requires but one set of conductors, the total weight of conductors required for a given number of lamps, (keeping the total loss of effect due to this cause the same in both systems,) is as one, for the multiple-light system, to the square of the number of lamps for the single-light system. To illustrate: suppose sixteen lights are operated at a given distance from the dynamo-electric machine or machines, and the loss of current due to resistance of conductors is limited to a certain amount; and let the weight of conductors required in the multiple-light system be represented by 1; then the weight of conductors required in the single-light system will be $16^2=256$. Hence, in operating a large number of lights at a long distance from the source of power by the single-light system, either an enormously expensive system of conductors must be employed, or else a great part of the whole energy of the currents will be wasted in overcoming the resistance of the smaller conductors.

This objection to the single-light system is fatal, when any

considerable separation of the machines and lamps becomes necessary.

The Brush system of lighting being free from this defect, the lights may be maintained at a great distance from the source of power with very little loss of effect, and by means of conductors of moderate size and cost. The resistance of number 10 (Stubb's gauge) copper wire of commercial purity, is about .6 ohm per thousand feet; therefore 7600 feet of such a conductor will equal in resistance, only one of the sixteen lamps already described;

$$\frac{4.56.}{.6} \times 1000 = 7600.$$

so that fifteen lamps of full power could be operated through such a conductor of this length: or the whole sixteen, with a loss of only about six per cent. in effect. Only fifty per cent. of the total effect would be sacrificed by working through such a conductor more than eleven miles in length, (60800 feet) and this loss might be reduced one half by doubling the size of the conductor, which would still be of moderate dimensions.

No reference has yet been made to the use of more than sixteen lamps in the circuit of the No. 7 machine; but 17 or 18 lamps are often employed with the machine running at its normal speed of 750 revolutions per minute, and with good effect, although the total light produced is less than with sixteen lamps. At the speed at which the above described measurements were made, viz. 770 revolutions, 19 or 20 lamps may be burned with tolerably good effect, although the maximum amount of light is obtained with 16.

As many as 33 lamps have been operated simultaneously in the circuit of a No. 7 machine running at a speed of 800 revolutions per minute, with an arc of appreciable length in each lamp; but the total light produced was less than half that obtained when 16 or 17 lamps were employed. When the number of lamps operated by the No. 7 machine running at full

speed, is reduced below 16, the brilliancy of the remaining lights is of course increased, but not in proportion to the reduction in number. Hence the total amount of light is diminished. The *quantity* and *intensity* of the current are such as to produce the maximum light in 16 arcs.

At the time Mr. Holmes measured the power required to drive the sixteen-light machine, he also measured that required by a six-light machine of the size and style known as "No. 5."

This machine furnished six beautiful lights in single circuit, similar to those of the No. 7 machine, but with somewhat shorter arcs. (It will be remembered that the No. 7 machine was driven above its normal rate of speed.) The total power required to drive this machine was 4.5 horse power. The following are Mr. Holmes' figures:

Total power developed with the 6 light machine at 922 revolutions "closed,"	7.18 H. P.
Less friction load of engine "light,"	2.44 "
" " due to increase of load (7.18—2.44=4.74) at 5 per cent	.24 "
Total power required by 6 light machine	4.50 "

No measurements of the current from this machine were made.

REMARKS.

Much has been written by eminent electricians, and others, about the enormous loss of total lighting effect which follows the use of more than one centre of light in an electric circuit. Some state that the total light diminishes as the square of the number of lights increases; others, that the loss is as the cube of the number of lights.

These extraordinary assertions are made without any reference to the energy or character of the current employed, and are never supported by any experimental data.

The experience of the writer has uniformly shown that when a small amount of electrical energy is expended at several points, very little or no light results: while if the same energy

be properly expended at one point, a large amount of light may be evolved. On the other hand, when a *large* amount of current energy is properly expended at a number of points not too great, the total light produced may nearly equal that evolved when the whole energy is concentrated at one point.

A certain amount of energy is required before any light at all is produced, and if the division falls below this point nothing in the way of light results. But after a certain point is reached, at which a good light is produced, then the increase of light appears to be almost directly as the increase of energy exhibited in the arc, the length of the latter remaining constant. Mr. Schwendler's experience here appears to coincide with our own. In his report, before mentioned, he says: "If we make the highly probable supposition that the resistance of an arc of constant length is inversely proportional to the current which passes through, then the light produced would be proportional to the current. This appears to be the case." Again he says: "Although the light must be very nearly proportional to the total energy consumed in the arc, the resistance of the arc decreasing with the increase of current, it follows that the light *cannot* be proportional to the square of the current."

It is argued by many, that an increase of energy in the arc, produces a corresponding increase of temperature of the carbons, and that, according to a well known law, the light must increase much faster than the temperature. But in fact, after a certain point is reached, the temperature of the positive or light-giving carbon does *not* increase with increase of current, but the area of surface heated to maximum, increases almost directly with the current. The "certain point" several times alluded to, is at that stage of the process when vaporization takes place over a well defined spot on the positive carbon. Obviously, when rapid evaporation has commenced, the temperature of the carbon cannot be increased at that point, and an increase in the

amount of heat evolved, can only result in an increase in the rapidity of vaporization, or vaporization over an increased area.

A careful study of the voltaic arc, and of the carbon points after being used with currents of various strength, cannot fail to convince the most skeptical, of the truth of these assertions.

Quite contradictory to the spirit of those portions of Mr. Schwendler's report—already quoted, he says in another place: "If more than one light is produced in the same circuit, by the same current, the external or available light becomes rapidly dearer with increase of the number of lights produced. For this reason already, if not for many others, the *division of light* must result in an engineering failure."

It seems scarcely possible that Mr. Schwendler could have overlooked the obvious fact, that a current representing a given amount of energy, and adapted to produce the maximum light from one center, may, by having its dimensions suitably altered, *i. e.* its electro-motive force increased, and its volume diminished, while its energy remains the same, be adapted to produce its maximum light from several small centers, instead of from one large one, (provided, of course, the energy at each center is not reduced below the "certain point" before defined.) Yet he seems to have overlooked, or entirely ignored, this fact.

The performance of the No. 7 Brush machine with its sixteen lamps, already detailed, proves unquestionably that the division of a large current energy among many lights in the same circuit, or more properly, the *multiplication* of lights on a single circuit, has resulted in a great engineering *success.*

The votaries of the single-light system would advocate in place of the single No. 7 Brush machine, the use of *sixteen* small machines, with their costly system of conductors. *Each* of these would require as much attendance, and involve as much expense for repairs, as the single large machine. At least fifty per cent. and probably one hundred per cent. more driving power would

be required to produce sixteen lights of the same size, and the first cost of the apparatus would be vastly greater. Further, if the lights were required at any considerable distance from the source of power, the single-light system must prove *entirely* impracticable.

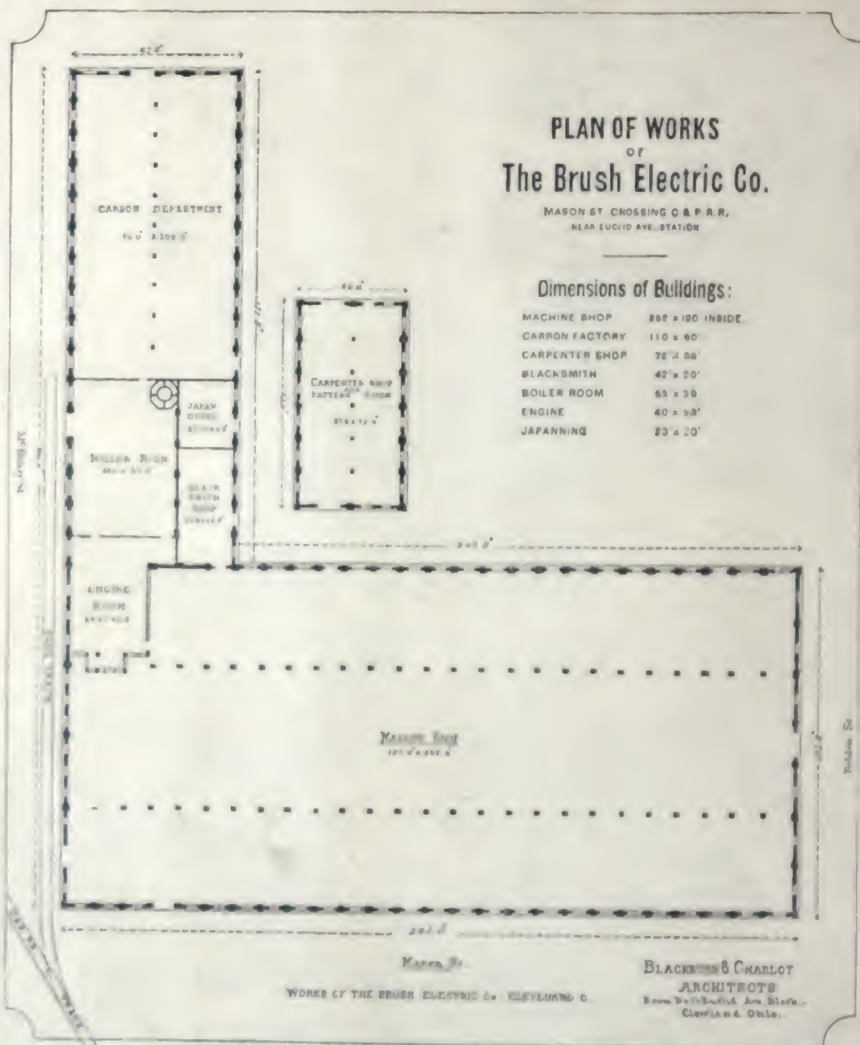
CLEVELAND, September, 1879.

PLAN OF WORKS
OF
The Brush Electric Co.

MASON ST. CROSSING C & P R.R.
NEAR EUCLID AVE. STATION

Dimensions of Buildings:

MACHINE SHOP	262 x 100 INSIDE
CARBON FACTORY	110 x 60'
CARPENTER SHOP	72 x 38'
BLACKSMITH	42' x 20'
BOILER ROOM	65 x 39
ENGINE	40 x 28'
JAPANNING	23 x 20'



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